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Some observations on the development and bionomics
of larvae of *Filicollis anatis* Schrank

[Parasitofauna of the biocoenosis of Drużno Lake — part VII]

Kilka obserwacji nad rozwojem i biologią larw *Filicollis*
anatis Schrank

[Parazytfauna biocenozy jeziora Drużno — część VII]

During my investigation on the occurrence of larval forms of *Acanthocephala* in the body cavity of *Asellus aquaticus* in Drużno Lake (Styczyńska, 1958) I found some larvae possibly belonging to the species *Filicollis anatis* Schrank. To prove this supposition I have made an experimental culture concerning the development of the worm.

To a glass dish full of pond water I put some embryos previously taken out from the body cavity of the gravid females of *Asellus aquaticus*. During 48 hours I did not give the food to make them eat the embryos, afterwards I fed them with filiform algae (*Waukeeria* and others). From time to time I had dissected invaded crustaceans. Observations over the acanthocephalan larvae were made in vivo without staining.

In general I made such experiments twice. The greatest obstacle was a very high mortality rate among invaded isopods which caused that only a part of them could be examined.

In my first experiment between August 10th and September 9th 1953 19 isopods were examined among them twelve were invaded and twenty six larvae were found. The second experiment was made in winter (November 15th 1953 — April 1st 1954) under conditions that it should take longer to obtain older stages of development. Therefore I have made the first dissection of isopods after a month.

The larvae from the second culture were much more advanced in their development. In this case I had examined ten isopods and found 94 larvae in them.

Description of some developmental stages

Acanthella I* (Fig. 1).

It was the youngest larva I have observed. The body of larva was oval, round or pear-shaped with one (or sometimes two) short appendage resembling a tail. In this appendage there were no nuclear elements, but only a few granular substances. Four times

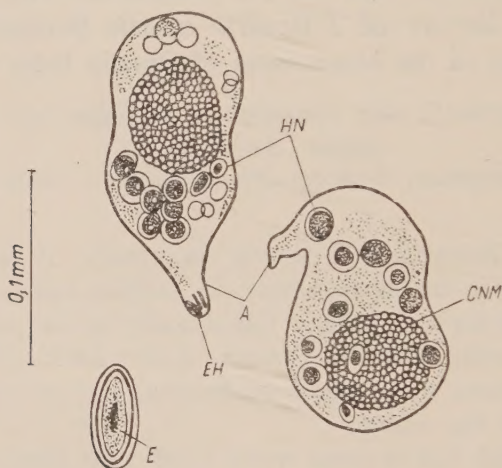


Fig. 1. *Acanthella* I. A — appendage; CNM — central nuclear mass; E — embryo; EH — embryonal hooks; HN — hypodermal nuclei

I observed at its end some (three to five) embryonal hooks. A mass of embryonal nuclei can be seen as a dark ball in the inside of the larval body. Several large subcuticular nuclei were placed round the central nuclear mass. The average measurements of the larvae were 0.15 mm in length and 0.11 mm in breadth.

Such forms appear in the body cavity of an isopod on the fifth day since the moment of putting crustaceans to the contact with acanthocephalan embryos and were found even after a month. The progress of their development was rather slow. Except the fact that in plasma there appeared a lot of dark granules and the larvae

* All the terminology according to Van Cleave, 1947.

became less transparent, no other changes occur. These granules are probably the products of metabolism of the larva gathered in its body. They became invisible in the preserved specimens. Slow development in the first stages of postembryonal life of *Acanthocephala* was observed also by Meyer (1931) during his investigations on *Macracanthorhynchus hirudinaceus* Pall. This period in the case of swine thorny-headed-worm amounts to eleven weeks and for *F. anatis* — according to my observations — from three up to four weeks.

The older forms come from the second culture: from December 15th 1953 till January 11th 1954 I found a *canthellae* quite developed and very close to the juvenile forms, after January 11th I found some juvenile forms able to invade a final host. All larvae of a *canthella* series had the body more or less elongate and were wrapped in the thin hyaline cysts.

A form least developed

Its body was divided into three separate segments: the body region, the proboscis region and the region of the collar and the neck. The body is an oval, elongate sack with a thick hypoderma and little transparent, which caused that I could not observe the development of the ligament sack. The body is non-transparent because of the pigment in the inside. It is similar to the pigment found in previcus forms and makes an impression that it fills the hypodermal lacunar system.

The external layer covering the anlage of the organs in the collar and neck region, is fairly transparent, of homogenous structure with small separate granules in it.

In the proboscis region on its apical end, we can find a small cavity in the external layer and under the layer there is visible a mass of glittering nuclear vesicles: they form the anlage of the brain, proboscis and proboscis receptacle. On the top of this nuclear mass I have observed about ten smaller vesicles forming the apical nuclear ring. From these vesicles towards the back goes a shein of fibrillas — the anlage of retractor muscle. In the neck region on both sides of the muscular shein there are two dark sacks — the anlagen of lemnisci.

The measurements of this form were 0.51 mm in length and 0.17 mm in breadth.

The next stage (Fig. 3).

It differs in comparison with the former one: the larva is larger (0.93 mm long and 0.26 mm wide). It has a precise division of the whole body into the trunk, the collar, the neck and proboscis. Pigment appears not only in the trunk but also in the collar where

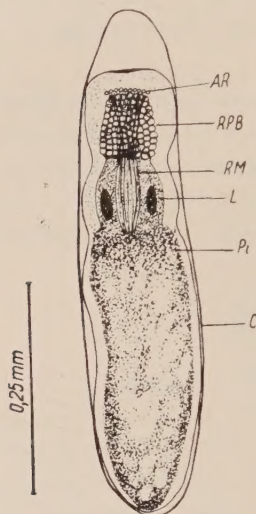


Fig. 2. Older stage of acanthella. AR — apical ring; C — cyst; L — lemniscus; Pi — pigment; RM — retractor muscle; RPB — anlage of proboscis, proboscis receptacle and brain

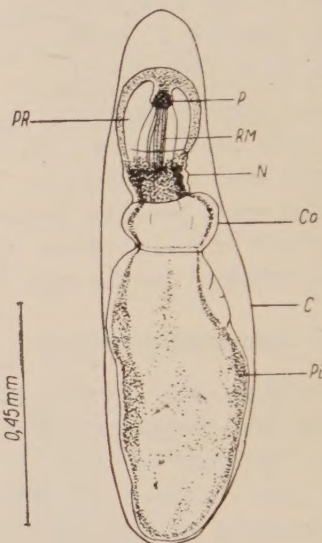


Fig. 3. The next stage of acanthella. C — cyst; Co — collar; N — neck; P — proboscis; Pi — pigment; PR — proboscis receptacle; RM — retractor muscle

there is its greatest agglomeration. On both sides of the muscle shein appeared a clear space. It is the beginning of proboscis receptacle. The muscular shein begins at the end of a dark apical mass of embryonal nuclei — in further stages of development it became the brain and proboscis of the worm.

Acanthella near a juvenile stage (Fig. 4).

The last stage of a *acanthella* series is very similar to a normal juvenile form, i.e., proboscis, the neck, the collar and the trunk take their final shape achieved in the first host.

A mace-like proboscis — identical on this stage for both sexes — cover the hooks in eighteen longitudinal rows and ten to eleven hooks in each row. Proboscis is not yet retracted into the receptacle and it is a basic difference separating this stage from the invasive one.

(Moore, 1946: „If the proboscis is invaginate within the body cavity of the living acanthella... the acanthella may be considered infective.”).

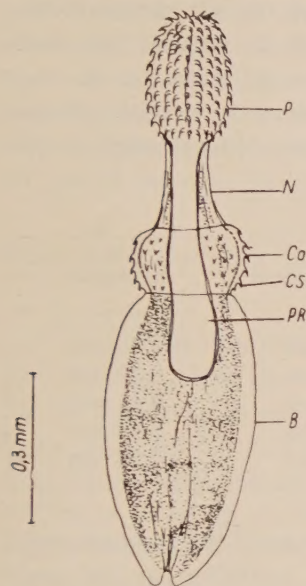


Fig. 4. Acanthella near a juvenile stage. B — trunk; Co — collar; CS — cuticular spines; N — neck; P — proboscis; PR — proboscis receptacle

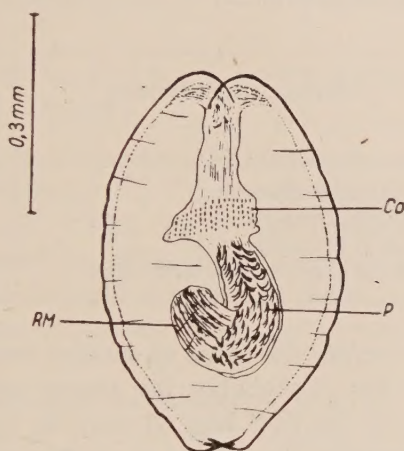


Fig. 5. Invasive juvenile stage (with retracted proboscis). Co — collar; P — proboscis; RM — retractor muscle

The neck is long, proboscis receptacle finally developed, the collar covered with cuticular spines. Hypoderma of the body became thicker and in vivo the anlagen of the organs in the body cavity are not visible.

Measurements: length of the trunk 0.60 mm; breadth of the trunk 0.30 mm; length of the proboscis 0.38 mm; breadth of the proboscis 0.16 mm; length of the neck together with the collar 0.30 mm.

Juvenile form (Fig. 5; Plate I, phot. 1).

Except further thickening of the hypoderma of the body and permanent retraction of the proboscis into the receptacle, this form does not differ very much from the above mentioned. On this stage larva does not develop and passively waits for the moment it enters the final host.

When I compared the results of experimental invasion with the results of natural one in Družno Lake I have observed that the measurements of larvae from experimental culture were always smaller — for example the trunks of the juveniles were 0.56 — 0.68 mm long and 0.30 — 0.38 mm wide in the culture, in comparison with 0.80 — 1.04 mm long and 0.48 — 0.70 mm wide in nature. In conditions of experimental culture the intensity of invasion is very high — in every invaded crustacean there develop several larvae, while in isopods from natural habitat there were found singular juveniles of *Filicollis*.

Average measurements	In experiment	In nature
Length of the trunk	0.60 mm	0.85 mm
Breadth of the trunk	0.30 mm	0.50 mm
Length of proboscis	0.40 mm	0.44 mm
Breadth of proboscis	0.16 mm	0.18 mm
Length of neck together with collar	0.30 mm	0.50 mm

Therefore the cause of smaller measurements of the experimental specimens is probably the poorer quality of nutrition in the body cavity of the first host. It may be the result of the worse nutrition of isopods in the culture or of the greater number of parasites developing in a single host (Michajłow, 1953).

The development of *Filicollis anatis* described above is very similar to the development of other species of *Acanthocephala* described by Meyer (1931), Kates (1943), Moore (1946), Rašin (1949) and others.

The embryo (acanthor) which pierced the intestine wall of an arthropod and entered its body cavity in the first period of its development becomes motionless and grows up. Its body appears to have two layers. The external layer of a syntitial character covers an internal dense mass of embryonal nuclei. The first period of a very slow growth of the larva without visible morphological changes is followed by the period of differentiation of internal nuclear mass. The growth becomes more intensive simultaneously. From the internal nuclear mass comes to the front of the body the anlage of future brain, proboscis and proboscis receptacle. In the back of the anterior nuclear group appears the anlage of retractor muscle and a ligament

sack with the initial genital organs. These anlagen in the juvenile form achieve the final form obtained in the first host.

None of the organs of *F. anatis* is developed definitively in its juvenile form. In the final host the size and shape of the proboscis are changed, the larval collar disappears joining the front part of the body, the genital organs develop from the small anlagen and sexual dimorphism become distinctly visible. In the literature I found the affirmation of these experimental results in a short note (Candler, 1950) that *Asellus aquaticus* is the first host for *Filicollis anatis*, but I did not find a detailed description of its development.

The behaviour of juvenile forms in non specific final hosts

I had experimented the artificial invasion with the juveniles of *F. anatis* of white mice (*Mus musculus* L.). I expected results similar to those obtained by Reish (1950) for *Polymorphus kenti* Van Cleave, a parasite typical for birds from the genus *Larus*. Reish invaded white rats with juvenile forms of *P. kenti* and after some times he found in their intestines grown up — while sexually immature specimens.

The invasion was made according to the method of Reish, i. e., several (about twenty two) larvae of *Filicollis* were injected with the help of a pipet into the pharynx of four specimens of *Mus musculus*. It happened on April 1 — in a fortnight (April 13) in the intestines of the first examined mouse I found three specimens of *F. anatis* encysted in the mesentery. After a month (May 1) in the body of the second mouse I found three specimens similarly encapsulated.

Two other examined mice were not at all invaded.

The juveniles found in mesentery were alive in both cases and they did not differ from the injected forms neither from the point of growth nor development.

Since in the examined mice I found only six from the total number of twenty two injected larvae, I suppose that the rest failed on piercing to the body cavity and there were thrown away with feces or by vomiting motion of pharynx after the pipet was taken out. The fact that juveniles of *Acanthocephala* pierce the wall of the intestine entering body cavity as an inoffensive environment in the case of a non-specific host is typical for some species of this group.

In their life cycle appears a normal intermediate host, not a necessary one (Van Cleave, 1923) but only paratenic or transport host (Baer, 1952).

The examples of experimental invasion of the non-specific paratenic hosts are known (Moore, 1946) where the behaviour of acanthocephalan larvae was identical like in the case of *Filicollis* and mice.

Of course in the nature there are not more possibilities for aquatic isopods to be eaten by a mouse than for a mouse to be eaten by a duck. But the behaviour of parasite in this artificial situation proves its great abilities in adaptation to bad conditions which may occur in its life cycle.

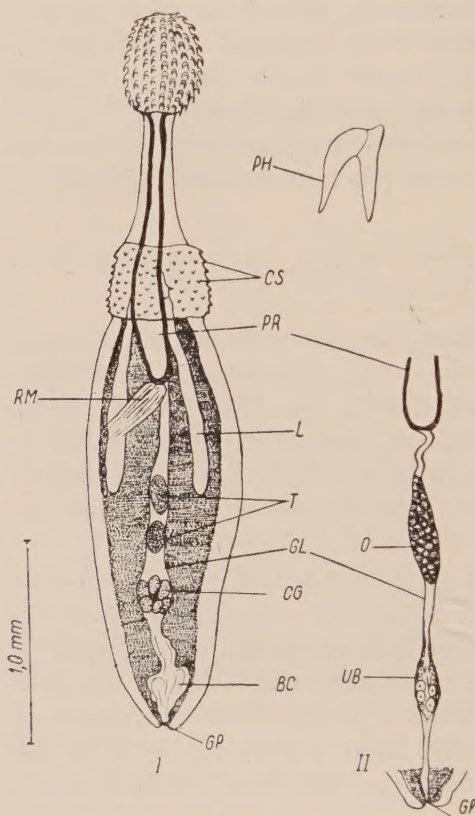


Fig. 6. Immature *Filicollis anatis* Schrank from *Philomachus pugnax* L. I — male; II — anlage of female genital organs. BC — bursa copulatrix; CG — cement glands; CS — cuticular spines covering the collar; GL — genital ligament; GP — genital pore; O — ovary; PH — proboscic hook; PR — proboscis receptacle, RM — retractor muscle; UB — uterine bell

In the second way of adaptation the worms may remain alive in the intestine of the non-specific host and develop there partially, but they can not mature in these conditions.

During my investigations made at Družno Lake in 1950, 1951 and 1953 there were found several times in the intestines of *Tringa glareola* L. and *Philomachus pugnax* L. about forty acanthocephalans identified as *F. anatis* (Styczyńska, 1958).

All the worms were sexually immature and of small size. The sexual dimorphism was not distinctly visible — the males and females were of the same size and proboscis of both sexes was iden-

tical. The collar was jointed with the front part of the female trunk in a few cases only (see Plate I, phot. 2, 3 and 4).

The measurements of the recovered specimens were as follows:

length of the proboscis 0,32—0,4 mm; breadth of the proboscis 0,2—0,3 mm; length of the neck 0,34—0,5 mm; length of the collar 0,3—0,36 mm; length of the proboscis receptacle 0,46—1,2 mm; length of the testes 0,13—0,2 mm; breadth of the testes 0,066—0,1 mm; length of the lemnisci 1,03—1,04 mm; length of the hooks 0,35—0,51 mm.

Fediushin (1956) who experimented with the hens and juveniles of *Polymorphus magnus*, a parasite of wild ducks — obtained similar results to those observed in nature, i. e., *P. magnus* remain alive in the intestine of the non-specific host developing partially but not coming to maturity.

Conclusions

1. An experimental confirmation was obtained of the supposition that *Asellus aquaticus* L. is the first host of *Filicollis anatis*.

2. A description of some developmental stages was given. The full development of the worm in the crustacean takes two months (at room temperature).

3. There were observed two modes of behaviour of the acanthocephalan juveniles in a non-specific final host: a. they pierced into the body cavity of the host (an experimental host — *Mus musculus* L.) or b. they remained alive in the intestine of the non-specific host but did not reach sexual maturity (natural hosts — *Tringa glareola* L. and *Philomachus pugnax* L.).

These observations were made at the Department of Parasitology, Warsaw University, under the direction of Prof. Dr. W. L. Wiśniewski to whom the author's sincere thanks are due.

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STRESZCZENIE

Na podstawie wskázówek uzyskanych w czasie poprzednich badañ autorki nad larwami *Acanthocephala* występującymi u *Asellus aquaticus* L. na jeziorze Družno (S t y c z y ń s k a, 1958) przeprowadzono eksperymentalne zarażenie ośliczek zaródkami *Filicollis anatis*, pospolitego kolcogłowa ptaków kaczkowatych. Uzyskano wynik pozytywny, ustalający ośliczkę jako żywiciela pośredniego dla *F. anatis*.

Przeprowadzono 2 hodowle zarażonych skorupiaków, sekcjonując je w kilkudniowych odstępach czasu w celu zaobserwowania stanu rozwoju pasożytów. Obserwacje przeprowadzano in vivo bez barwienia. Ustalono, że w temperaturze pokojowej rozwój pasożyta od stadium acanthora do inwazyjnej formy juvenilnej trwa dwa miesiące. Podano opisy i rysunki kolejnych stadiów rozwojowych, wykazujące, że rozwój *Filicollis* przebiega w analogiczny sposób jak rozwoje innych gatunków opisywane w literaturze.

Zwrócono uwagę na gromadzenie się w ciele larw w trakcie rozwoju ciemnych ziarenek, będących prawdopodobnie produktami przemiany materii pasożytów.

Zauważono, że postacie juvenilne pochodzące z zarażenia naturalnego są zawsze większe od larw rozwiniętych w hodowli.

Autorka upatruje przyczynę tego zjawiska w niedostatecznej ilości pokarmu, jaką mają do dyspozycji pasożyty z hodowli, rozwijające się zwykle w większych ilościach w jednym skorupiaku w porównaniu z larwami z zarażenia naturalnego występującymi w ośliczkach zwykle pojedynczo.

Przeprowadzono obserwacje nad zachowaniem się inwazyjnych larw w niewłaściwym żywicielu ostatecznym.

W tym celu zarażono 4 białe myszy 22 larwami *F. anatis*. U jednej z zarażonych myszy po dwóch tygodniach, a u drugiej po miesiącu znaleziono otorbione w krezce 3 żywe larwy, które przebiły się z jelita do jamy brzusznej.

Autorka interpretuje takie zachowanie się larw jako charakterystyczną dla kolcogłowów i dość powszechnie obserwowaną właściwość przystosowawczą, pozwalającą im na przetrwanie w razie przypadkowego trafienia do niewłaściwego żywiciela.

Drugim sposobem przystosowania się pasożyta jest pozostawanie w jelicie niewłaściwego żywiciela, ale bez osiągnięcia dojrzałości płcio-

wej. Zjawisko takie, obserwowane także przez Fediuszina (1956) u kur zarażonych eksperymentalnie larwami *Polymorphus magnus*, zauważyła autorka u ptaków *Philomachus pugnax* L. i *Tringa glareola* L., zarażonych przez *F. anatis* na drodze naturalnej.

Plate I

Phot. 1. Invasive juvenile form of *Filicollis anatis* from experimental culture (proboscis inverted under the pressure of cover glass).

Phot 2. *F. anatis* from *Philomachus pugnax* — proboscis.

Phot. 3. *F. anatis* from *Ph. pugnax* — front part of the body.

Phot. 4. *F. anatis* from *Ph. pugnax* — back part of the male body.

